Hotspot defects are known to cause reliability problems in both thin-film and conventional c-Si modules. Detection of hotspots in completed modules can identify potential failures before the module is installed in the field. We describe several root causes for hotspot failures in PV modules, and demonstrate an infrared measurement technique, IRIS™, to quickly identify and characterize the severity of module hotspots.

**Hotspots: Common Causes**

- **Cell Manufacture**
  - Incomplete edge isolation
  - Crystalline defects intersecting junction
  - Metal-decorated cracks
  - Overfiring: pn junction "punchthrough"
  - Scribeline shunts- incomplete removal or redeposition
  - Metal particles & bridges on backside
  - Print alignment errors

- **Module Manufacture**
  - High resistance or “cold” solder points
  - Current mismatch between cells

**Typical Damage (x-Si)**

- **Mild (<80°C rise)**
  - Low damage probability
- **Moderate (~80-200°C rise)**
  - Backsheet bubbles
  - Coverglass cracking
- **Extreme (>200°C rise)**
  - Cell damage

**Moisture Intrusion**

- Corrosion & Power Loss
- Warranty failure.

**Manufacturing Requirement**

- Reduce Warranty Exposure by identifying hotspot modules with high reliability (>99.9% accurate) inspection.

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**Module Measurement Method**

- **Method:** Lock-in & Time-resolved Thermography
- **Patents Pending**
- **Camera:** LWIR (8-12 micron)
- **Speed:**
  - a) Inline: ~20 seconds / module
  - b) R&D: 30ms- 5 min.

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**Summary**

Using this technique, hotspots may be conclusively identified before or during field installation with IRIS inspection machines capable of >25 modules per hour. The technique works in ambient light and directly measures the local heating due to defects.